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Influence of Organic and Bio-Fertilization on Productivity, Viability and Chemical Components of Flax Seeds

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A FIELD experiment was carried out in a private farm at El-Sharawy village, El-Bostan area, Nubaria region during the two growing seasons of 2006/2007 and 2007/2008. The aim of this study is to investigate the effect of organic manure and bio-fertilizers as a partial replacement of mineral fertilizers on productivity, chemical component and viability of flax (*Linum usitatissimum* L.) seeds (cultivar Sakha 1). Two levels of farmyard manure (FYM) *i.e.*, 20 and 30 $m^3 fed^{-1}$ with 50% of the recommended N and P fertilizers and four treatments of bio-fertilizers, *i.e.*, un-inoculated, Bio I (P-dissolving bacteria), Bio II (multi strains of P- dissolving bacteria and N - fixing bacteria) and mixture of Bio I + Bio II were examined.

The results indicated that flax growth parameters and the yield as well as chemical composition of seeds were increased with increasing FYM rate. In general application of either FYM at the rate of $30 m^3 fed^{-1}$ with 50% of the recommended dose of N and P or bio-fertilizers significantly increased plant growth parameters, *i.e.*, plant height, fruiting zone length and total fiber length. Also, marked increments in yield components, *i.e.*, No. of capsules $plant^{-1}$, No. of seed $capsule^{-1}$, seed index and weight of seed $plant^{-1}$ were obtained. Moreover, seeds content of oil, protein and carbohydrates as well as N, P and K removals to seeds were also increased as compared with plants fertilized with full recommended dose of NP or un-inoculated plants. The interaction effect between FYM with 50% of the recommended dose of N and P and bio-fertilizers inoculation induced significant increase in growth parameters, seed quality and seed chemical composition.

The best results were obtained with application of FYM at rate of 30 $m^3 fed^{-1}$ with 50% of recommended NP in the presence of mixture of bio-fertilizers. For Sodium Dodecy Sulfate-Polyacrylamide Gel Electrophoresis (SDS-PAGE), the highest number of protein bands was recorded in plants which treated with the low rate of FYM + 50% NP when inoculated with Bio II or mixture of Bio I + Bio II. The study therefore, recommended that application of organic manure at the rate of 30 $m^3 fed^{-1}$ with 50% of mineral fertilizer and

inoculation with bio-fertilizers is the best treatment for producing high quality flax seeds in sandy soil and obtaining suitable quality of chemical composition. For such soil of reclaimed land which has low amounts of macro and micro nutrients, should be fertilized by the economically beneficial bio-fertilizer to save about 50% of the mineral fertilizers.

Keywords: Farmyard manure, *Linum usitatissimum* L., Flax seeds, Yield and chemical components, Phosphate dissolving bacteria, N-fixingbacteria, SDS- PAGE.

Flax (*Linum usitatissimum* L.) is an important crop in Egypt for its oil and fiber yields. Oil content of flax seeds is about 40 %, which is considered an important source of essential polyunsaturated fatty acids in the human diet. Crude protein content ranged from 27 to 29.2%, whereas the total carbohydrates ranged from 23.1 to 25% according to the genotype. Improving yield and quality of flax could be achieved by sowing high yielding cultivars and applying suitable cultural practices. Growing crops in sandy soils is faced by various problems, and the most important one is the low fertility, as well as the low water retention and poor physical, chemical and biological properties of such soils. Improving such conditions could be accomplished by the application of organic materials as well as bio-fertilizers in addition to the mineral fertilizers (Naguib,2006).

Organic manures application within a rotation is effective in supplying N and other nutrients to the soil for use by the following crop (Mostafa, 2002), stimulate biological soil activity, build up soil organic matter content and soil structure, prevent leakage of soluble nutrients from the soil, bring crop nutrients up from lower soil profiles and increase the general level of fertility by mobilizing minerals and building up the organic matter and the nitrogen content and preventing weed seedling growth (Saunders, 2000 and Mahmoud *et al.*, 2003). Moreover, Aly (1999) on maize in sandy soils, Abdel-Rasoul *et al.* (2002) on flax in sandy soil, Ewais *et al.* (2004) on pea plants in sandy soils, Shukry *et al.* (2007) on flax in calcareous soil and El-Gazzar (2007) found that adding FYM to flax plants significantly increased fiber length, number of capsules plant^{-1}, seed yield plant^{-1}. Also increasing organic fertilizer rate significantly increased most characteristics.

Nowadays, on the way of clean agriculture through applying products with minimum pollution effects, the use of bio-fertilizers is recommended by several investigators to substitute the chemical fertilizers (El-Aggory *et al.*, 2001 and Abd El-Magid, 2002). Bacillus megaterium PDB was the most important group in the solublization process of insoluble phosphorus in soils (El-Kathat, 1992). The application of the pre-prepared bio-fertilizers of various bacterial in mixture have become recently a new technique which is having a define role in plant growth, yield and transformation of nutrients (N, P and K) in plants (Hewedy, 1999 and Shaalan, 2005). Mostafa *et al.* (2003) and Zahana & Abo-Kaied (2007) found that, bio-fertilizer application significantly increased growth, yield parameters and oil content in flax plants.

The electrical conductivity test is more commonly used to determine seed vigor of crops. It is based on the principle that seeds which are loosing vigor release materials, such as sugars or other electrolytes out the seed into the soil solution, may increase the activity of soil fungi which in turn may infect and interfere with the development of seedling growth, especially under cold and wet condition (El-Galfy, 2005).

The aim of this study was to throw more light on using organic and bio-fertilizers for improving flax productivity and seed quality on one hand and minimizing the use of chemical fertilizers that pollute the environment on the other hand.

Material and Methods

This study was conducted during the two successive growing seasons of 2006/2007 and 2007/2008. The experimental site is a newly reclaimed sandy soil at El-Sharawy Village, El-Bostan area, Nubaria region where sprinkler irrigation system is generally used. The initial physical and chemical characteristics of the soil were determined according to Klute (1986) and Page *et al.* (1982), which showed that the soil was sandy in texture (sand 92.5% and 92.2%) with $CaCO_3$ 2.15% and 1.90%, O.M 0.42% and 0.35%, total N 0.08 and 0.05%, pH 7.95 and 8.1, EC 0.60 and 0.95 dSm^{-1} and available N was 20.0 and 25.0$\mu g\ g^{-1}$, in the two respective seasons.

Seeds were sown in rows 20 cm apart and three meters long. The plot area was 3 x 3.5 m (10.5 m^2). There was a guide experimental plot with recommended doses of mineral nitrogen and phosphorus i.e. 45 kg N $fed.^{-1}$ and 30 kg P_2O_5 fed^{-1}. The experimental plots were arranged in split plot in RCB design with three replications. The organic matter rates (2 treatments) were allocated to main plots and inoculation treatments (4 treatments) were allocated to sub plots.

Farmyard manure in the rate of 20 and 30 m^3 $fed.^{-1}$ was uniformly incorporated into the soil layer of 20 cm depth with power tiller two weeks before planting. The soil was lightly irrigated to establish a good microbial activity for decomposing the organic fertilizer in suitable time before sowing seeds of flax cultivar (Sakha 1). Chemical analysis of FYM showed 31.5% O.M, 18.5% C, 1.46% N, 0.56% P, 0.5% K, 0.9% Ca, 20% moisture, density 0.5 ton m^{-3} and C: N 12.7:1.

Seeds were inoculated before sowing with (Bio I) phosphate dissolving bacteria (B.megatherium), (Bio II) multi strain of P-dissolving bacteria (B.megatherium) and N- fixing bacteria (*Azospirillum sp.*) and mixture of them (Bio I + Bio II). These bio-fertilizers were prepared and commercially distributed by the General Organization of Equalization Fund, Ministry of Agric., Egypt.

The other cultural practices were applied as recommended for flax crop in sandy soils. Plots of organic treatments received 50% only of recommended rates of nitrogen and phosphorus (50% NP).

The crop was harvested 200 days after planting, and representative samples were collected to study total yield, yield components, seed viability and nutrient content of seeds.

Tests of seed viability and seed quality were carried out in the Laboratory of Seed Technology at Giza, Agric. Res. Center. Oil quality, *i.e.*, free fatty acid % (F.F.A.) and acid value mg g^{-1}(A.V.) as well as moisture, carbohydrate, crude protein, N, P and K contents were determined according to procedures outlined in A.O.A.C. (1990). Electrical conductivity (E.C.) was determined according to procedure described by A.O.S.A. (1983). Seed samples withdrown from each treatment were taken to determine standard germination %, length of shoot and root and dry weight of seedlings under optimum conditions according to ISTA (1999). Seedling vigor index was calculated according to ISTA (1985) by the formula given bellow:

Seedling vigor index = seedling length (cm) X germination %

Protein bands were determined for seeds from each treatment (as bulk of the two seasons) using SDS-PAGE (Sodium Dodecy Sulfate-Polyaccrylamide Gel Electrophoresis) according to the method of Laemmli (1970).

The obtained data were exposed to the proper statistical analysis of variance according to Snedecor and Cochran (1981). L.S.D at 5% level of significance was used for comparison between means.

Results and Discussion

Productivity

Growth parameters

Data in Table 1 revealed that there is an increment of fruiting zone length, plant height and total fiber length due to applying FYM+ 50% NP in both seasons being higher with increasing the rate of FYM to 30 m^3fed^{-1} + 50%NP. This treatment increased fruiting zone length, plant height and total fiber length to be 129, 108 and 106% that of the NP recommended (guide treatment) respectively in the combine of two seasons. Moreover, there were significant increase in fruiting zone length, plant height and total fiber length in plants inoculated with bio-fertilizers as compared with the plants un-inoculated. Plants inoculated with Bio I + Bio II were superior followed by those inoculated by Bio II then Bio I. Plants inoculated with Bio I and Bio II showed increments of 145, 113 and 109% - over those of plants only received NP recommended- for fruiting zone length, plant height and total fiber length, respectively. The increase in growth by FYM might be attributed to the increase of available nitrogen at root primordial (primitive) in which cytokinin is synthesized. In addition, there was a close relationship between root primordial and leaf area duration and also rapid leaf expansion which lead to an increase in photosynthesis, and this in turn increased the productivity (Merghany, 1999).

The obtained results are in accordance with those of Ewies *et al.* (2004) on pea plants in sandy soil, who found that, the combination of FYM with inorganic fertilizer (1/4 N + PK) was more effective on growth or yield components than the organic manure treatment alone.

TABLE 1. Mean values of some growth characters of flax plants as affected by organic and bio-fertilization for two seasons and their combination.

Treatments		Fruiting zone length (cm)			Plant height (cm)			Total Fiber length (cm)		
Organic Fert.	Bio-fertilizer	1st	2nd	Comb	1st	2nd	Comb	1st	2nd	Comb
50% NP + 20 m^3 fed^{-1} FYM	Un-inoculated	12.4	13.2	12.8	83.4	83.7	83.2	72.4	72.0	72.1
	Bio I	15.0	13.8	14.4	89.3	88.1	88.7	73.4	72.5	73.0
	Bio II	17.0	18.0	17.5	94.2	90.1	92.1	75.3	75.6	75.5
	Bio I + Bio II	19.2	18.9	19.1	98.5	94.4	96.5	79.7	75.3	77.5
Mean		15.9	16.0	15.9	91.4	88.9	90.2	75.2	73.8	74.5
50% NP + 30 m^3 fed^{-1} FYM	Un-inoculated	15.5	15.2	15.4	92.1	87.7	89.9	76.9	72.7	74.8
	Bio I	15.4	14.8	15.1	91.8	87.5	89.6	75.0	74.1	74.9
	Bio II	19.0	17.7	18.3	96.4	92.6	94.5	76.7	76.8	76.8
	Bio I + Bio II	19.6	18.7	19.2	98.9	94.0	96.5	79.9	75.6	77.8
Mean		17.4	16.6	17.0	94.8	90.4	92.6	77.1	74.8	76.0
Effect of bio-fertilizer:										
Un-inoculated		14.0	14.2	14.1	87.8	85.7	86.6	74.6	72.3	73.5
Bio I		15.2	14.3	14.7	90.5	87.8	89.2	74.2	73.3	73.9
Bio II		18.0	17.8	17.9	95.3	91.3	93.3	76.0	76.2	76.1
Bio I + Bio II		19.4	18.8	19.1	98.7	94.2	96.5	79.8	75.5	77.7
LSD at 5%:										
FYM		NS	NS	NS	0.39	NS	2.06	1.16	NS	NS
Bio-fertilizer		2.08	1.97	1.04	1.35	6.09	2.96	2.06	NS	2.34
FYM X bio-fertilizer		2.94	2.78	1.48	1.91	8.61	4.18	2.92	NS	3.32
Recom. (100%NP)		12.6	13.7	13.2	81.1	85.1	85.6	71.4	71.2	71.3

Also, El-Gazzar (2007) mentioned that increasing organic fertilizer rate significantly increased technical stem length and fiber length of flax plants. Shukry *et al.* (2007) noticed that addition of water hyacinth dry manure improved the metabolic activities and fiber yield of flax plants. The same trend was obtained by inoculating flax genotypes seeds with bio-fertilizers (Zahana and Abo-Kaied, 2007).

The interaction between (FYM + 50%NP) and bio-fertilizer showed significant increases in the mean values of growth characters mentioned before. This observation hold fairly true for the two growing seasons. The significant increase in vegetative growth parameters as a result of application of FYM with bio-fertilizers may be attributed to the incident increase in net assimilation rate.

Also, bio-fertilizers produced adequate amounts of indole acetic acid and cytokinin, which increased the surface area per unit root length. Also, mixture of bio-fertilizer and FYM acted mainly in increasing the availability of nitrogen, consequently increasing its absorption by the plant and this may led to an increase in cell division which in turn encourages the plant growth to go forward.

Yield Parameters

Table 2 shows significant increments in average No. of capsules plant $^{-1}$, No. of seeds capsule $^{-1}$, seed index and weight of seeds plant $^{-1}$ in both growing seasons and consequantly their combination, due to the application of FYM +50 % NP. Moreover, it revealed the superiority of plants received the highest rate of FYM (30 m^3 fed^{-1}). In this respect, it is known that addition of FYM to the sandy soil, improved its structure and other related properties, consequently existence of a better chance for good growth occurred. Moreover, it would induce the slow release of nutrients to ensure availability of nutrients to plants for a longer period. Higher values of such traits in both growing seasons have been obtained due to the application of Bio I + Bio II in comparison with un-inoculated plants or with those treated with either Bio I or Bio II separately. The enhancement in growth as a result of bio-fertilizer inoculation may be due to the action of micro-organisms of bio-fertilizers in the availability of N, P and K nutrients, or may be due to the production of phyto hormones. It is known that N, P and K are very important in most growth processes and the influence of N on new cells formation and growth and then yield. Similar results were obtained by Abd El-Rasoul and El-Azzouni (2002) and El-Azzouni & El-Banna (2003).

The interaction between (FYM + 50 % NP) and bio-fertilizers indicated the superiority of bio-fertilizer inoculation and applying the highest rate of FYM (30 m^3 fed^{-1}). The significant increase might be related to increasing the availability of mineral fertilizers and N fixation that may lead to an increase in photo synthesizing. Therefore, an increase in accumulation of carbohydrates in seed occurred and subsequently resulted in an enhancement in seed parameters. In addition, to that the highest rate of bio-fertilizer led to increase element contents, which may led to an increase in cell division in subsurface organs, thereby enhanced the growth and yield.

Viability

It worthy to mention that seed viability denotes to the ability of a seed to germinate rapidly and produce a normal seedling under a wide range of conditions.

It was observed from Table 3 that flax seeds obtained from plants received the high rate of FYM + 50% NP significantly increased germination%, seedling qualities, *i.e.*, shoot length, root length, seedling dry weight and seedling vigor index. Electrical conductivity was higher in seeds obtained from plants received the low rate of FYM (20 $m^3 fed^{-1}$ + 50% NP).

Flax seeds obtained from the bio-fertilizer treatment of Bio I or Bio II and their mixture, demonstrated higher germination%, shoot and root length, seedling dry weight and seedling vigor index. In contrast, bio-fertilizers decrease E.C. values of which is a desirable effect, because of increasing E.C. indicates that seeds loosing vigor (El-Galfy, 2005).

TABLE 2. Mean values of yield components of flax plants as affected by organic and bio-fertilization for two seasons and their combination.

Treatments		Av. No. of capsules Plant^{-1}			No. of seeds capsule^{-1}			Seed Index (1000 seed wt.) (g)			Wt. of seeds plant^{-1} (g)		
Oganic Fert.	Bio-fertilizer	1st	2nd	Comb	1st	2nd	Comb	1st	2nd	Comb	1st	2nd	Comb
50% NP + 20 m^3 fed^{-1} FYM	Un-inoculated	6.00	6.00	6.00	6.97	6.93	6.95	8.60	8.53	8.57	0.36	0.36	0.36
	Bio I	6.60	6.93	6.77	7.00	7.13	7.07	8.75	8.70	8.72	0.40	0.44	0.42
	Bio II	8.77	8.93	8.85	7.97	8.17	8.07	8.89	8.91	8.90	0.62	0.65	0.63
	Bio I +Bio II	8.87	9.73	9.30	8.53	8.37	8.45	9.22	9.29	9.25	0.70	0.76	0.73
Mean		7.56	7.90	7.73	7.62	7.65	7.64	8.86	8.86	8.86	0.52	0.55	0.54
50% NP + 30 m^3 fed^{-1} FYM	Un-inoculated	7.00	7.90	7.45	7.50	7.70	7.60	8.79	8.84	8.82	0.46	0.54	0.50
	Bio I	7.57	8.83	8.20	7.73	7.93	7.83	8.84	8.71	8.78	0.52	0.61	0.56
	Bio II	7.63	8.77	8.20	8.13	8.23	8.19	8.97	9.03	9.00	0.63	0.65	0.64
	Bio I +Bio II	9.17	9.77	9.47	8.70	8.63	8.67	9.10	9.33	9.21	0.73	0.78	0.76
Mean		7.84	8.82	8.33	8.02	8.13	8.07	8.93	8.98	8.95	0.59	0.64	0.62
Effect of bio-fertilizer:													
Un-inoculated		6.50	6.95	6.73	7.23	7.32	7.28	8.70	8.69	8.69	0.41	0.45	0.43
Bio I		7.08	7.88	7.49	7.37	7.53	7.45	8.80	8.70	8.75	0.46	0.53	0.49
Bio II		8.20	8.85	8.52	8.05	8.20	8.13	8.93	8.97	8.95	0.63	0.65	0.64
Bio I + Bio II		9.02	9.75	9.38	8.62	8.50	8.56	9.16	9.31	9.23	0.72	0.77	0.74
LSD at 5%:													
FYM		0.38	0.22	0.14	0.27	0.28	0.13	0.06	0.08	0.03	0.01	0.02	0.01
Bio-fertilizer		0.33	0.30	0.21	0.21	0.17	0.13	0.08	0.09	0.06	0.03	0.02	0.02
FYM X bio-fertilizer		0.48	0.40	0.30	0.29	0.24	0.19	0.11	0.13	0.08	0.05	0.03	0.03
Recom.(100%NP)		5.90	5.93	5.91	7.13	7.07	7.10	8.66	8.53	8.60	0.66	0.52	0.59

Seed viability was positively affected by the interaction between FYM + 50% NP and bio-fertilizer. Also, a negative relationship between E.C and seed germination% took place, which indicated that more cell leakage escaped from deteriorated seed and lowered the germination% of seeds. This significant interaction effect was observed during the two seasons.

Seed quality and chemical composition

Oil quality

Data in Table 4 evidently reveal insignificant increments in oil% of seeds due to applying FYM and -as expected- acid value (A.V) or free fatty acids (F.F.A) in the oil was decreased. The best treatment which does not significantly increased oil% and significantly decreased A.V. or F.F.A. is FYM in the rate of 30 m^{3}fed^{-1} + 50% NP.

TABLE 3. Mean values of flax seed viability parameters as affected by organic and bio-fertilization for two seasons and their combination.

Treatments		Germination (%)			Shoot length (cm)			Root length (cm)			Seedling dry wt. (g)			Seedling vigor index			Electrical conductivity (µscm^{-1}g^{-1})		
Organic Fert.	Bio-fertilizer	1st	2nd	Comb	1st	2nd	Comb	1st	2nd	Comb	1st	2nd	Comb	1st	2nd	Comb	1st	2nd	Comb
50% NP + 20 m^3 fed^{-1} FYM	Un-inoculated	71.3	68.3	69.8	3.53	3.36	3.44	3.43	3.37	3.40	5.31	4.72	5.02	502.6	459.8	481.2	83.6	74.7	79.2
	Bio I	69.7	76.0	72.8	3.42	3.90	3.66	3.42	3.73	3.58	5.18	5.93	5.55	477.0	579.1	528.1	70.1	71.7	70.9
	Bio II	72.7	78.0	75.3	4.61	3.53	4.07	3.94	3.78	3.86	5.79	5.69	5.74	621.9	569.9	595.9	70.4	60.1	65.2
	Bio I + Bio II	82.0	73.3	77.7	4.77	4.11	4.44	4.08	3.72	3.90	6.06	5.82	5.94	727.4	573.8	650.6	61.3	65.8	63.5
Mean		73.9	73.9	73.9	4.08	3.72	3.90	3.72	3.65	3.69	5.59	5.54	5.56	582.2	545.6	563.9	71.3	68.1	69.7
50% NP + 30 m^3 fed^{-1} FYM	Un-inoculated	73.0	76.3	74.7	4.08	3.76	3.92	3.72	3.55	3.64	5.72	5.17	5.45	569.8	558.6	564.2	74.3	80.5	77.4
	Bio I	75.7	75.3	75.6	4.17	3.68	3.92	3.64	3.82	3.73	5.62	5.81	5.72	560.9	570.0	565.5	68.1	70.4	69.3
	Bio II	77.0	79.0	78.0	3.82	5.09	4.46	3.98	4.20	4.09	5.95	5.49	5.72	600.6	733.4	667.0	66.7	61.1	63.9
	Bio I + Bio II	85.0	75.3	80.2	4.29	4.73	4.51	4.61	3.72	4.17	5.59	5.94	5.77	756.1	636.9	696.5	61.5	56.8	59.2
Mean		77.7	76.5	77.1	4.09	4.32	4.20	3.99	3.82	3.91	5.72	5.60	5.66	621.4	624.7	623.0	67.7	67.2	67.4
Effect of bio-fertilizer:																			
Un-inoculated		72.2	72.3	72.3	3.81	3.56	3.68	3.58	3.46	3.52	5.51	4.94	5.23	536.2	509.3	522.7	79.0	77.6	78.3
Bio I		72.7	75.7	74.2	3.80	3.79	3.79	3.53	3.77	3.65	5.40	5.87	5.63	519.0	574.5	546.8	69.1	71.0	70.1
Bio II		74.8	78.5	76.7	4.22	4.31	4.26	3.96	3.99	3.98	5.87	5.59	5.73	611.2	651.6	631.4	68.6	60.6	64.6
Bio I + Bio II		83.5	74.3	78.9	4.53	4.42	4.48	4.35	3.72	4.03	5.82	5.88	5.85	741.8	605.3	673.6	61.4	61.3	61.4
LSD at 5%:																			
FYM		NS	1.90	2.07	NS	0.51	0.17	0.22	NS	0.12	NS	0.06	0.13	NS	62.0	32.37	NS	NS	NS
Bio-fertilizer		4.81	4.72	3.19	0.36	0.29	0.22	0.26	0.24	0.17	0.28	0.24	0.17	54.9	44.2	38.29	6.86	5.83	4.26
FYM X bio-fertilizer		6.80	6.67	4.51	0.51	0.41	0.31	0.37	0.34	0.23	0.39	0.34	0.25	77.7	62.5	66.78	9.70	8.25	6.03
Recom.(100%NP)		66.7	65.0	65.8	3.22	3.27	3.25	2.55	3.70	3.12	5.35	4.73	5.04	385.1	454.1	419.6	82.6	89.3	86.0

TABLE 4 Mean values of oil quality of flax seeds as affected by organic and bio-fertilization for two seasons and their combination

Treatments		Oil (%)			Acid value (A.V.) (mgg^{-1})			Free fatty acids (F.F.A.) (%)		
Organic Fert.	Bio-fertilizer	1st	2nd	Comb	1st	2nd	Comb	1st	2nd	Comb
50% NP + 20 m^3 fed^{-1} FYM	Un-inoculated	36.3	36.8	36.5	0.91	0.92	0.92	0.45	0.48	0.46
	Bio I	37.2	36.7	37.0	0.69	0.79	0.74	0.34	0.42	0.38
	Bio II	37.7	37.6	37.7	0.69	0.77	0.73	0.42	0.27	0.35
	(Bio I + Bio II)	38.4	37.8	38.1	0.67	0.67	0.67	0.29	0.36	0.33
Mean		37.4	37.2	37.3	0.74	0.79	0.76	0.38	0.38	0.38
50% NP + 30 m^3 fed^{-1} FYM	Un-inoculated	36.9	37.6	37.3	0.82	0.66	0.74	0.34	0.41	0.37
	Bio I	36.8	37.5	37.1	0.82	0.64	0.73	0.32	0.39	0.36
	Bio II	38.2	37.7	38.0	0.60	0.68	0.64	0.42	0.32	0.37
	(Bio I + Bio II)	37.8	38.6	38.2	0.58	0.64	0.61	0.26	0.33	0.30
Mean		37.4	37.8	37.6	0.71	0.66	0.68	0.34	0.36	0.35
Effect of bio-fertilizer:		36.6	37.2	36.9	0.87	0.790	0.83	0.39	0.44	0.42
Un-inoculated		37.0	37.1	37.1	0.76	.72	0.74	0.34	0.41	0.37
Bio I		38.0	37.7	37.8	0.65	0.73	0.69	0.42	0.29	0.36
Bio II		38.1	38.2	38.2	0.63	0.66	0.64	0.28	0.35	0.31
(Bio I + Bio II)										
LSD at 5%:										
FYM		NS	NS	NS	NS	0.06	0.03	0.04	NS	0.02
Bio-fertilizer		0.98	0.72	0.58	0.07	0.06	0.04	0.03	0.03	0.02
FYM X bio-fertilizer		1.39	1.03	0.82	0.10	0.08	0.05	0.04	0.05	0.03
Recom (100%NP)		36.6	37.1	36.9	1.10	0.87	0.99	0.44	0.55	0.50

Moreover, data showed that, the significant increase in oil quality, *i.e.*, A.V. or F.F.A. % was detected due to applying bio-fertilizers. However, bio-fertilizers significantly increased oil%. The highest values were obtained from plants inoculated with mixture of Bio I + Bio II. In this respect, Mostafa *et al.* (2003) and Zahana & Abo-Kaied (2007) reported that, bio-fertilizer application significantly increased oil content and oil yield fed^{-1}.

The interaction between FYM+ 50% NP and bio-fertilizer showed a significant influence on the oil% in seeds obtained from plants inoculated with mixture of Bio I + Bio II under the high rate of FYM. The same treatment gave the highest depression in A.V. and F.F.A. in both growing seasons compared with those obtained from un-inoculated plants and received the lowest rate of FYM or plants received the full recommended rate of NP. This observation hold fairly true for the two growing seasons.

Chemical composition

Protein %, carbohydrate %, moisture contents % and N, P and K removals to seeds are presented in Table 5. These parameters were positively affected by applying FYM + 50% NP and the highest rate of FYM was the most superior. The same trend was obtained with the application of bio-fertilizer for both seasons. This means that two sources of fertilizers are very suitable for nutrition of flax plant, especially under sandy soils characterized by low organic matter content. In this respect, Aly (1999) and Ewais *et al.* (2004) obtained the same trend but on maize and pea plants, respectively in sandy soils. These results may be due to increasing the availability of NPK- elements through improving soil conditions. In contrast, FYM or bio-fertilizers inoculation decreased moisture% of seeds comparing with that recorded from uninoculated plants or plants received full recommended dose of NPK. The reduction in seed moisture is desirable since it is good for seed storage. Similar results were obtained by Abd El-Rasoul and El-Azzouni (2002) and El-Azzouni & El-Banna (2003).

Highly significant increases in N, P and K removals to seeds as well as protein and carbohydrate contents resulted from the interaction between the additions of FYM +50% NP and bio-fertilizer.

These results might be due to the action of micro organisms of bio-fertilizers on FYM material and its transformation processing. Whereas, such treatments decreased moisture% in seeds, so seeds can be stored for longer period without exposure to mould infection. Higher moisture content may increase respiratory activities of seed and shorten the seed lives. Cellular membranes of short-life seeds became weaker and permitted cell contents into water, which increased the E.C of seed.

Identification protein bands on SDS-PAGE

The SDS-PAGE for soluble seed protein electrophoresis was used to investigate the genetic differences among the treatments of flax grown in sandy soils. The electrophoresis banding patterns of protein extracted from seeds of flax are shown in Fig. 1 and 2. The bands pattern clearly indicated wide differences in number and position on the bands.

The interaction between FYM + 50% NP and bio-fertilizers had an effect on switching off or on some of the cell genetic capability, it can no longer use some of the genes function which still exists in its nucleus, that appeared in the total numbers of protein bands. The changed pattern of gene expression may be due to the treatments and/or physiological and environmental changes.

TABLE 5 . Mean values of some seed quality parameters and its chemical composition of flax as affected by organic and bio-fertilization for two seasons and their combination.

Treatments		Moisture (%)			Protein (%)			Carbohydrates (%)			N removal in seed (mg N $plant^{-1}$)			P removal in seed (µg P $plant^{-1}$)			K removal in seed (mg K $plant^{-1}$)		
Organic Fert.	Bio-fertilizer	1^{st}	2^{nd}	Comb	1^{st}	2^{nd}	Comb	1^{st}	2^{nd}	Comb	1^{st}	2^{nd}	Comb	1^{st}	2^{nd}	Comb	1^{st}	2^{nd}	Comb
50% NP + 20 m^3 fed^{-1} FYM	Un-inoculated	7.27	7.30	7.29	23.6	23.3	23.7	20.0	22.6	21.3	14.2	13.4	13.8	44.7	45.2	44.9	8.22	8.05	8.14
	Bio I	7.22	7.27	7.24	25.4	23.4	24.4	23.6	22.2	22.9	16.2	16.5	16.3	67.3	72.0	69.7	10.1	10.1	10.1
	Bio II	7.08	7.42	7.25	25.7	26.5	26.1	25.1	23.8	24.4	25.5	27.4	26.4	120.8	127.0	123.9	14.1	14.5	14.3
	Bio I + Bio II	7.26	7.23	7.24	26.3	26.1	26.2	25.7	25.2	25.4	29.4	31.6	30.5	151.8	166.1	158.9	13.5	13.9	13.7
Mean		7.21	7.30	7.26	25.3	24.8	25.1	23.6	23.4	23.5	21.3	22.2	21.8	96.1	102.6	99.4	11.5	11.6	11.6
50% NP + 30m^3 fed^{-1} FYM	Un-inoculated	7.40	7.21	7.31	22.9	26.5	24.7	22.9	23.6	23.2	16.8	22.7	19.8	80.4	95.2	87.8	8.94	9.72	9.33
	Bio I	7.26	7.28	7.27	26.3	24.9	25.6	24.0	24.5	24.2	21.7	24.3	23.0	94.8	112.8	103.3	12.7	14.3	13.5
	Bio II	7.11	7.13	7.12	26.1	26.4	26.3	24.6	25.9	25.3	26.4	27.3	26.9	142.6	143.5	143.0	15.4	15.0	15.1
	Bio I + Bio II	7.22	7.12	7.17	27.0	27.0	27.0	25.3	25.7	25.5	31.7	33.9	32.8	213.8	226.8	220.3	17.0	17.8	17.4
Mean		7.25	7.19	7.22	25.6	26.2	25.9	24.2	24.9	24.6	24.2	27.0	25.6	132.9	144.6	138.7	13.5	14.2	13.8
Effect of bio-fertilizer:																			
Un-inoculated		7.34	7.26	7.30	23.3	25.2	24.2	21.4	23.1	22.3	15.5	18.1	16.8	62.5	70.2	66.4	8.58	8.89	8.73
Bio I		7.24	7.28	7.26	25.8	24.2	25.0	23.8	23.3	23.6	19.0	20.4	19.7	81.1	92.4	86.7	11.4	12.2	11.9
Bio II		7.10	7.27	7.18	25.9	26.5	26.2	24.9	24.9	24.6	26.0	27.3	26.6	131.7	135.2	133.5	14.7	14.7	14.7
Bio I + Bio II		7.24	7.17	7.21	26.7	26.3	26.5	25.5	25.5	25.5	30.5	32.7	31.6	182.8	196.5	189.6	15.3	15.9	15.6
LSD at 5%:																			
FYM		NS	0.12	NS	NS	NS	NS	NS	0.82	0.93	0.68	0.08	0.71	10.9	3.84	3.72	1.89	2.09	0.91
Bio-fertilizer		0.12	NS	0.08	0.78	0.72	0.50	2.34	0.81	1.11	1.66	1.02	0.92	7.37	4.93	4.20	1.23	1.10	0.78
FYM X bio-fertilizer		0.17	NS	0.12	1.10	1.03	0.71	3.32	1.15	1.57	2.35	1.44	1.30	10.4	6.97	5.94	1.74	1.55	1.10
Recom . (100%NP)		7.16	7.42	7.29	23.7	23.6	23.6	21.2	22.7	22.0	13.7	13.6	13.6	41.3	40.4	40.8	8.00	7.93	7.96

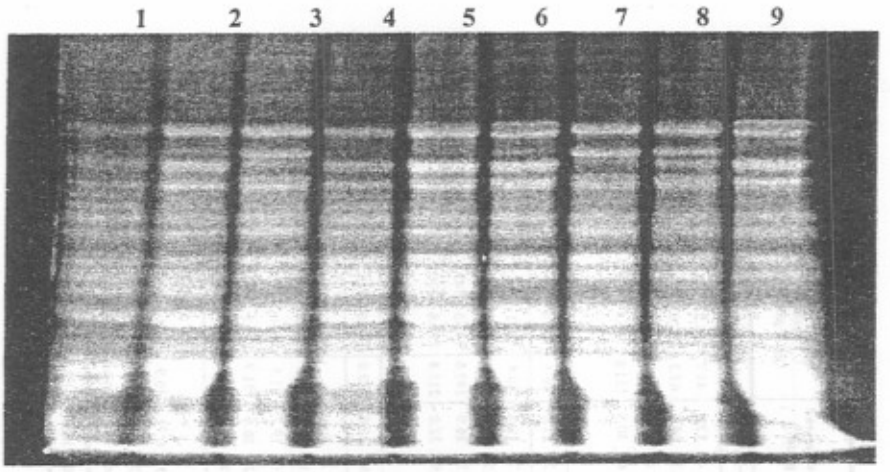

Fig. 1.SDS-PAGE protein banding patterns for proteins of treated flax seeds.

1- NP. 2- FYMI + 50% NP. 3- FYMI + 50% NP + Bio I. 4- FYMI + 50% NP + Bio II.
5- FYMI + 50% NP + Bio I+ Bio II. 6-FYMII + 50% NP. 7- FYMII + 50% NP + Bio I.
8- FYMII + 50% NP + Bio II. 9- FYMII + 50% NP + Bio I+ Bio II.

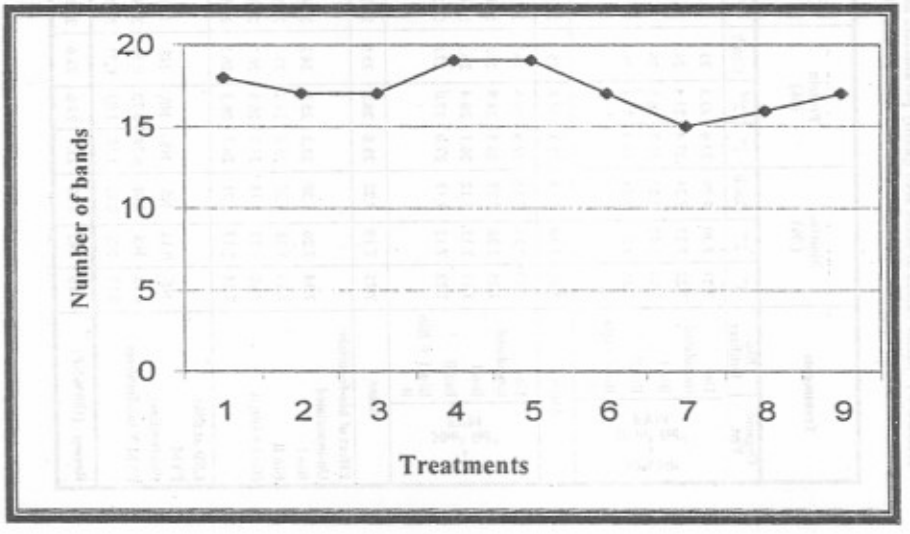

Fig. 2. Relationship between number of protein bands and flax treatments.

1- NP. 2- FYMI + 50% NP. 3- FYMI + 50% NP + Bio I. 4- FYMI + 50% NP + Bio II.
5- FYMI + 50% NP + Bio I+ Bio II. 6-FYMII + 50% NP. 7- FYMII + 50% NP + Bio I.
8- FYMII + 50% NP + Bio II. 9- FYMII + 50% NP + Bio I+ Bio II.

Highest number of protein bands was recorded from plants treated with the low rate of FYM + 50% NP and inoculated with Bio I + Bio II.

Conclusion

Data show that application of organic fertilizers is highly useful compared to the mineral ones. There is a need for further research to determine whether FYM can be used economically to replace or supplement mineral fertilizers for crop production. Therefore, it can be concluded that under the conditions of the applied research, FYM at the rate of 30 m^3 fed^{-1} is beneficial besides reducing the pollution of environment. The results also emphasize the role of seed inoculation with bio-fertilizers to reduce the rate of N and P fertilizer needs.

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تأثير التسميد الحيوي والعضوي على إنتاجية ، حيوية والمحتوى الكيماوي لبذور الكتان

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أجريت تجربة حقلية فى مزرعة خاصة فى قرية الشعراوى -منطقة البستان- النوبارية خلال موسمى ٢٠٠٦/٢٠٠٧، ٢٠٠٧/٢٠٠٨ (التربة رملية) بهدف دراسة تأثير التسميد العضوى والتسميد الحيوى كبديل جزئى للسماد المعدنى على انتاجية وحيوية وجودة بذور نبات الكتان صنف سخا (١). استخدم لذلك مستويين من التسميد العضوى (٣٠،٢٠ م^3 للفدان) مع اضافة ٥٠ ٪ من الكمية الموصى بها من التسميد النتروجينى والفوسفاتي وأربع معاملات من التسميد الحيوى وهي بدون تلقيح للبذور أوتلقيح بالبكتيريا المذيبة للفوسفور (سماد حيوي I) أوتلقيحها بخليط من البكتريا المذيبة للفوسفور والبكتريا المثبتة للنتروجين (سماد حيوي II) أوتلقيح البذور بمزيج من سماد حيوي I + سماد حيوي II مقارنة بالتسميد المعدني(نيتروجيني وفوسفاتي) بالمعدلات الموصى بها.

ازداد النمو والانتاجية والمحتوى الكيماوى للبذور مع زيادة معدل الاضافة من السماد العضوى للتربة. ادت اضافة السماد العضوى بمعدل ٣٠ م^3 للفدان مع اضافة ٥٠ ٪ من السماد المعدنى النتروجينى والفوسفاتى او السماد الحيوى الى زيادة النمو (ارتفاع النبات – طول المنطقة الثمرية – طول الالياف الكلى) وايضا

زيادة ملحوظة فى مكونات المحصول (عدد الكبسولات لكل نبات –عدد البذور لكل كبسولة –دليل البذرة –وزن البذور لكل نبات). كما ادى ايضا الى زيادة نسبة الزيت والبروتين والكربوهيدرات الكلية وامتصاص عناصر النتروجين والفوسفور والبوتاسيوم فى بذور الكتان. كما ادت الى زيادة نسبة الانبات وطول الريشة وطول الجذير والوزن الجاف للبادرة وكذلك دليل حيوية البادرة الناتجة من إنبات بذور كل معاملة، وبالعكس من ذلك ادى الى نقص كلا من نسبة الرطوبة ورقم الحموضة ونسبة الاحماض الدهنية الحرة وذلك عند المقارنة بالنباتات التى سمدت بـ ١٠٠٪ من التسميد النتروجينى والفوسفاتى (الكمية الموصى بها) والنباتات الغير ملقحة.

أحدث تأثير التفاعل الناتج من إضافة السماد العضوى للتربة مع إضافة ٥٠ ٪ من التسميد المعدنى وتلقيح البذور بالأسمدة الحيوية إلى زيادة معنوية فى صفات النمو وصفات البذرة الناتجة وزيادة المكونات الكيميائية للبذرة فى الأرض الرملية وكانت أفضل النتائج بإستخدام المعدل المرتفع من السماد العضوي و ٥٠ ٪ من السماد المعدنى فى وجود خليط من الأسمدة الحيوية.

توصى الدراسة بإستخدام معدل الإضافة ٣٠م^{3} للفدان من السماد العضوى مع نصف المعدل الموصى به من السماد المعدنى مع التلقيح بالأسمدة الحيوية حيث إنها كانت أفضل المعاملات لإنتاج بذور كتان ذات جودة عالية ومحتوى كيماوي مناسب فى التربة الرملية. وبالنسبة لمثل هذه الأراضى الصحراوية المستصلحة والمحتوية على مستويات منخفضة من المادة العضوية والعناصر المغذية الكبرى والصغرى فقد أصبح من وجهة النظر الإقتصادية ضرورة إستخدام الأسمدة الحيوية لتوفير ٥٠ ٪ من التسميد المعدنى على الأقل .